GEORGIA INSTITUTE OF TECHNOLOGY

OFFICE OF RESEARCH ADMINISTRATION

RESEARCH PROJECT INITIATION

Date: February 16, 1971

Project Title: Steady Three-Diemesional Motions

Project No: B-912

Principal Investigator Dr. Andrew W. Marris

Sponsor: National Science Foundation

Agreement Period: From 2-15-71 Until 2-14-73

Type Agreement: Grant No. GK-17654

Amount: $29,100 NSF Funds (B-912)
16,588 GIT Contribution (E-905)
$45,688 Total Budget

Reports Required: Annual Technical Letter Report; Final Technical Report (see separate Report Schedule). Final Fiscal Report (Controller's Office).

Sponsor Contact Person (s):

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Assigned to: School of Engineering Science and Mechanics

COPIES TO:

- Principal Investigator
- School Director
- Dean of the College
- Director, Research Administration
- Deputy Controller (2)
- Security-Reports-Property Office
- Patent Coordinator
- Library
- Rich Electronic Computer Center
- Photographic Laboratory
- Project File
- Other

RA-3 (2-71)

GEORGIA INSTITUTE OF TECHNOLOGY

OFFICE OF RESEARCH ADMINISTRATION

RESEARCH PROJECT TERMINATION

Date: September 7, 1973

Project Title: Steady Three-Dimensional Motions

Project No: E-23-603 (formerly B-912)

Principal Investigator: Dr. A. W. Marris

Sponsor: National Science Foundation

Effective Termination Date: 9/30/73

Clearance of Accounting Charges: by 9/30/73

Grant Closeout Items Remaining: Final Fiscal Report

School of ES&M

COPIES TO:

- Principal Investigator
- School Director
- Dean of the College
- Director of Research Administration
- Associate Controller (2)
- Security-Reports-Property Office
- Patent and Inventions Coordinator
- Library, Technical Reports Section
- Rich Electronic Computer Center
- Photographic Laboratory
- Terminated Project File No. _____
- Other _____

RA-4 (5/70)

E-23-603
Marris

ENGINEERING COLLEGE

GEORGIA INSTITUTE OF TECHNOLOGY

SCHOOL OF ENGINEERING SCIENCE
AND MECHANICS

225 NORTH AVENUE, N.W.
ATLANTA, GEORGIA 30332

April 20,1972

Annual letter
Technical Report.

Dr. Michael P. Gaus, Director
Engineering Mechanics Program
Division of Engineering
National Science Foundation
Washington, D.C. 20550

Dear Dr. Gaus:

To keep you posted on my progress on N.S.F. Grant E-23-603, may I submit the following information.

First, an enclosed paper by Marris and Shiau which completed one of the two outstanding exceptional cases of Ericksen's problem on universal deformations of perfectly elastic materials. This paper has had quite a little reference, which has pleased me. Since it is possible that I sent you a reprint of this, I enclose just one more reprint.

I have obtained some results in the study of universal motions of a Navier-Stokes fluid. I enclose two reprints of this for your files. I have been able to delimit two more cases of these motions, the case when the streamlines are rectilinear and the case when the Lamb surfaces are constant velocity surfaces. This work is presently being reviewed by Professor Chao-Cheng Wang for the Archive.

Professor Truesdell has recently submitted a small work called "Convection of Stretching", done jointly with Dr. Passman to ZAMM for me.

Perhaps the most difficult thing I have been trying to do is to give a decent proof of "Hamel's Theorem" which asserts that a vector-field which is both lamellar and solenoidal, and for which the vector-magnitude maintains a constant value on the vector-line, must consist of circular helices. Hamel's "proof" in 1937 had essentially all its steps and computations missing. It was more a statement that he had done it privately! Since that time several people have tried to get a proof but no one has succeeded. While it is a geometrical, vector-field type result, it relates to both fluid mechanics and elasticity. Dr. Shiau and I obtained three polynomial integrals between four variables, and showed that if these behaved at all normally the theorem would follow. Dr. Shiau obtained his Ph.D. for this work. Professors Truesdell and E.-C. Wang are both reading our work on this theorem at this time.

Sincerely,

A. W. Marris
Regents' Professor

AWM:vc
Encl
cc: Mr. A. A. Campt

E-23-603

ENGINEERING COLLEGE

GEORGIA INSTITUTE OF TECHNOLOGY

SCHOOL OF ENGINEERING SCIENCE
AND MECHANICS

225 NORTH AVENUE, N.W.
ATLANTA, GEORGIA 30332

September 4, 1973

Dr. George Lea
Engineering Mechanics Program
National Science Foundation
Washington, D. C. 20550

Re: Grant (GK)? KO-17654
Final Report

Dear Dr. Lea:

As my NSF Grant No. KO-17654 terminates on September 30, 1973, I am submitting this letter and the enclosed reprints as a final report.

Dr. Jye-Fu Shiau, who had worked with me earlier on the problem of the Universal Deformations in Incompressible Elastic Materials (ARMA 36, No. 2, 1970 enclosed), continued to work with me and obtained his Ph.D. in 1972, for achieving some basic background results for a proof of Hamel's theorem. This work will appear in Rendiconti del Circolo Matematico di Palermo. Offprints take rather a long time coming through from Italy, but I will send copies to NSF when I receive them. After Dr. Shiau left I was able to complete a proof of Hamel's Theorem (ARMA 51, No. 2, 1973 enclosed). The Palermo paper forms a background for this work. This whole business of proving Hamel's Theorem took a tremendous amount of time, but it is the best thing I've ever done.

I have worked on the problem of delimiting the steady universal motions of a Navier Stokes fluid; this is contained in the three enclosed papers (ARMA 51, No. 5; 50, No. 2; and 48, No. 5). The last of these three papers, incidentally, won one of the Sigma Xi Faculty Awards at Georgia Tech in 1973. The enclosed manuscript, "On Steady Universal Navier Stokes Motions," currently in press in Italy, (Rendiconti dell Istituto Lombardo), is also on this subject. I will forward offprints to NSF when they become available.

In collaboration with Dr. Passman I did the analysis, "Convection of Stretching," ZAMM 53. This represents roughly an analogue of the classical Cauchy vorticity transport theorem for the stretching or rate of strain.

Finally, this summer I have proved a theorem in the kinematics of circulation-preserving motions as contained in the enclosed manuscript, "Steady Isochoric Circulation-Preserving Motions Whose Stream-Lines are Plane Geodesics on the Lamb Surfaces." This result asserts that axi-symmetric motions and a few simple rectilinear motions represent all the exact solutions in a broad class of motions. This paper has not yet been reviewed; I plan to submit it to Arch. Rat. Mech. Anal.

Yours sincerely,

A. W. Marris, Regents' Professor

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